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THE SOLAR WIND FE/MG RATIO

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To meet the Genesis mission goal for improved solar elemental abundances, we need to address the issue of fractionation of the abundances of elements in the solar wind compared to the solar photosphere. There is a well-established depletion of elements in the solar wind with high first ionization potential (FIP > 9eV) compared to lower FIP elements, but there is no evidence for fractionation between lower FIP elements.

Using secondary ion mass spectrometry, we have measured the fluences of Fe and Mg for the “bulk” collector of the Genesis mission. Excellent solar wind depth profiles were obtained for Fe in diamond-like-carbon collector materials. Reasonable fluence agreement is found in replicate analyses among different samples. Integration of the depth profiles and comparison with an implant standard of known fluence yields an Fe fluence of $1.4 \times 10^{12}/cm^2$.

Excellent depth profiles for Mg in diamond-like-C are also obtained, but there are problems with fluence reproducibility, so at present, we base a Mg fluence on profiles measured in Si substrates. The profiles at shallow depths (<40 nm) appear to depend on whether a low pressure O_2 flood is used. Although additional study is required, the O_2 flood appears to significantly reduce problems due to Mg surface contamination. However, at depths than about 40 nm the flood and no-flood profiles are in good agreement, as are the derived fluences. Fourteen profiles in four different Si samples are consistent with a Mg fluence of $1.8 \times 10^{12}/cm^2$.

Thus, the present Genesis solar wind Fe/Mg ratio is 0.78, which is in good agreement with both spacecraft data and the abundance ratio derived from photospheric absorption line spectra. Our ultimate goal is to obtain Genesis abundance ratios accurate to ~5% two sigma for major elements, whose photospheric abundances are also well known.

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SPECTRO-DYNAMICAL ASTEROID FAMILIES

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Asteroid families are normally identified through similarities in proper orbital elements that are shared among the members of each family. It is commonly believed that asteroid families consist of remnants from the collisional disruptions of once larger parent bodies, and thus the members of each family should be genetically related, and their range in compositions should make cosmochemical sense.

Recent studies have tested the genetic reality of dynamical asteroid families through analyses of the spectral reflectance colors or taxonomic classifications of family members [1, 2]. While these studies have typically reported significant similarities in color between members of each family, these results are somewhat limited by their reliance on family memberships defined solely on orbital elements.

A new method of searching for asteroid families was proposed that combines both orbital and spectral information as part of the clustering process [3]. The initial application of this procedure focused on families in the middle of the main belt, using visible-wavelength spectra for 465 asteroids with semi-major axes between 2.7 and 2.8 AU. We now extend this method to cover the entire main belt, utilizing data for 2074 asteroids obtained during three major spectroscopic surveys: the first and second phases of the Small Main-belt Asteroid Spectroscopic Survey (SMASS) [4, 5] and the Small Solar System Objects Spectroscopic Survey (S3OS2) [6].

The clustering algorithm involves identifying pairs of objects with small differences (dissimilarities) in both orbital element and spectral component spaces. The well-established dynamical families are all confirmed using this approach, and several new families have been identified.

Results: The combination of both orbital and spectral information in the search for asteroid families has several advantages over previous studies that focus primarily on the distributions of orbital elements. By including spectral parameters in the cluster analysis, boundaries of known families can be more accurately determined, close or overlapping families in orbital element space can be separated, interlopers can be identified, and older, more diffuse families that might otherwise be missed can now be recognized. Preliminary results from this work show that, aside from variations in spectral slope, nearly every family appears to be spectrally homogeneous. There is no indication that we have sampled different lithologies within a single family that might be attributed to layering of a differentiated body (iron core, olivine-rich mantle, silicate crust). These results will help place important constraints on collisional models and on the processes of family formation.

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